UPRIGHT VACUUM CLEANER WITH CYCLONIC AIRFLOW

Background of the Invention

The present invention relates to vacuum cleaners. More particularly, the present invention relates to upright vacuum cleaners used for suctioning dirt and debris from carpets and floors.

Upright vacuum cleaners are ubiquitous. They are known to include an upper portion having a handle, by which an operator of the vacuum cleaner may grasp and maneuver the cleaner, and a lower cleaning nozzle portion which travels across a floor, carpet, or other surface being cleaned. The upper portion is often formed as a rigid plastic housing which encloses a dirt and dust collecting filter bag, although the upper portion may simply be an elongated handle with the filter bag, and an external cloth bag, being hung therefrom. The cleaning nozzle is hingedly connected to the upper handle portion such that the upper portion is pivotable between a generally vertical upright storage position and an inclined operative position. The underside of the nozzle includes a suction opening formed therein which is in fluid communication with the filter bag.

A vacuum or suction source such as a motor and fan assembly is enclosed either within the nozzle portion or the upper portion of the cleaner. The vacuum source generates the suction required to pull dirt from the carpet or floor being vacuumed through the suction opening and into the filter bag. A rotating brush assembly is typically provided in proximity with the suction opening to loosen dirt and debris from the

surface being vacuumed.

To avoid the need for vacuum filter bags, and the associated expense and inconvenience of replacing the bag, another type of upright vacuum cleaner utilizes cyclonic airflow, rather than a filter bag, to separate a majority of the dirt and other particulates from the suction airstream. The air is then filtered to remove residual particulates, returned to the motor, and exhausted.

Such prior cyclonic airflow upright vacuum cleaners have not been found to be entirely effective and convenient to use. For example, with these prior cyclonic airflow vacuum cleaners, the process of emptying dust and dirt from the cyclonic chamber dirt collection container has been found to be inconvenient, and often resulted in the spillage of the cup contents. Likewise, with these prior units, replacement of the filter element has not been convenient. Other cyclonic airflow vacuum cleaners have been found to exhaust air which is not free of residual contaminants. For example, one prior unit filters the airstream after it passes through the cyclonic chamber, but thereafter passes the airstream through the motor assembly where it is potentially recontaminated by the motor assembly, itself, prior to its being exhausted into the atmosphere.

Because the cyclonic action of such vacuum cleaners does not completely remove all dust, dirt, and other contaminants from the suction airstream, it is necessary to include a filter downstream from the cyclonic chamber. As such, prior cyclonic airflow vacuum cleaners have heretofore included conventional, non-

washable filter elements including a conventional filtering medium to filter the airstream after it passes through the cyclonic chamber. These prior filter elements have caused considerable difficulties. A conventional filter that is sufficiently fine to filter the airstream effectively unduly restricts airflow and decreases the effectiveness of the cyclonic action. On the other hand, a coarse filter does not effectively filter the airstream of residual contaminants. Further, conventional filter media, such as paper or fibrous media, has been found to clog readily, thereby unduly decreasing airflow rates over time. Thus, a need has been found for a cyclonic airflow vacuum cleaner with an effective filter positioned in the cyclonic chamber for effectively filtering the airstream without clogging. Further, a need has been found for such a vacuum cleaner including a washable, re-usable filter element from which dirt is easily extracted.

Accordingly, it has been deemed desirable to develop a new and improved upright vacuum cleaner that would overcome the foregoing difficulties and others while providing better and more advantageous overall results.

Summary of the Invention

In accordance with a first aspect of the present invention, an upright vacuum cleaner includes an upright housing and a nozzle base hingedly interconnected with the upright housing. The nozzle base includes a main suction opening in its underside. A cyclonic airflow chamber is defined in the upright housing and is

adapted for separating dust and dirt from a cyclonically circulating suction airstream. The main suction opening is in fluid communication with the cyclonic airflow chamber. A suction source is located in the upright housing or nozzle base and has a suction airflow inlet in fluid communication with the cyclonic chamber, and also includes a suction airflow outlet. A main filter assembly is located in the cyclonic chamber upstream from the suction source for filtering dust and dirt from a suction airstream that passes through the cyclonic airflow chamber. The main filter element extends upwardly within the cyclonic airflow chamber from a floor of a dirt container portion of said housing that defines a lower portion of the cyclonic airflow chamber and that is adapted for receiving and retaining dirt and dust separated from the suction airstream. A conduit depends into the cyclonic airflow chamber from an upper wall of the housing, and the conduit is axially aligned and mates with an upper end of the main filter assembly whereby the main filter assembly and the conduit together define a hollow column structure in the cyclonic airflow chamber.

In accordance with another aspect of the present invention, a vacuum cleaner comprises a first housing member defining a cyclonic airflow chamber adapted for separating entrained dirt and dust from a circulating airstream, and a second housing member defining a main suction opening. A first conduit fluidically connects the main suction opening to an inlet of the cyclonic airflow chamber. A suction source has a suction airstream inlet and a suction airstream outlet, and it is adapted for generating and maintaining a

suction airstream flowing from the inlet downstream to the outlet. A second conduit fluidically connects an outlet of the cyclonic airflow chamber to the suction airstream inlet of the suction source. A main filter assembly includes a filter medium comprising a selectively permeable plastic material, and the main filter assembly is located in the cyclonic chamber so that a suction airstream moving from the main suction opening to the inlet of the suction source by way of the cyclonic airflow chamber passes through the filter medium after the airstream moves in a cyclonic fashion within the cyclonic airflow chamber.

In accordance with still another aspect of the present invention, a vacuum cleaner apparatus includes a nozzle defining a main suction opening, and a main suction source in communication with the main suction opening. The main suction source is adapted for establishing a suction airstream that moves into the main suction opening and downstream into the suction source. A cyclonic chamber is placed in communication with and between the main suction opening and the suction source, and the cyclonic chamber is adapted for imparting a cyclonic flow to the suction airstream whereby a portion of particulates entrained in the suction airstream are separated therefrom, leaving residual particulates entrained in the suction airstream. A filter assembly is located in the cyclonic chamber and includes a filter membrane placed in covering relation with an outlet of the cyclonic chamber. Residual particulates entrained in the suction airstream are blocked from exiting the cyclonic chamber by the filter membrane, and the filter

assembly adapted for being selectively removed from the cyclonic chamber, washed to remove particulates from the membrane, and replaced in the cyclonic chamber for further filtering operations.

In accordance with yet another aspect of the present invention, a vacuum cleaner comprises a housing defining a cyclonic airflow chamber for separating contaminants from a suction airstream. The housing further defines a suction airstream inlet and a suction airstream outlet in fluid communication with the cyclonic airflow chamber. A nozzle base includes a main suction opening fluidically connected with the cyclonic airflow chamber inlet. An airstream suction source has an inlet fluidically connected to the cyclonic airflow chamber outlet and a suction source exhaust outlet. The suction source selectively establishes and maintains a suction airstream from the nozzle main suction opening to the suction source exhaust outlet. A main filter assembly is positioned in fluid communication between the cyclonic airflow chamber and the suction source and is adapted for filtering residual contaminants from the suction airstream downstream relative to the cyclonic airflow chamber. The main filter assembly comprising a polymeric filter membrane.

One advantage of the present invention is the provision of a new and improved vacuum cleaner.

Another advantage of the invention is found in the provision of a vacuum cleaner with a cyclonic airflow chamber through which the suction airstream flows for separating dust and dirt from the airstream and for depositing the separated dust and dirt into an easily and

conveniently emptied dirt cup.

Still another advantage of the present invention resides in the provision of a cyclonic airflow upright vacuum cleaner with a main filter that effectively filters residual contaminants from the suction airstream between the cyclonic airflow chamber and the motor assembly without unduly restricting airflow and without premature clogging. Yet another advantage of the invention is the provision of a cyclonic airflow upright vacuum cleaner with a final filter located downstream from the suction motor assembly for filtering the suction airstream immediately prior to its exhaustion into the atmosphere.

A further advantage of the invention is the provision of a vacuum cleaner with a main filter, an auxiliary filter, and a final filter wherein the main, auxiliary, final filters are easily removable and replaceable.

A still further advantage of the present invention is the provision of a vacuum cleaner with a cyclonic airflow chamber and main filter element, wherein the main filter element is positioned in a removable dirt cup partially defining the cyclonic airflow chamber for ease of emptying the dirt cup and cleaning the filter.

A yet further advantage of the present invention resides in the provision of a vacuum cleaner with a cyclonic airflow chamber and a main filter assembly situated in the cyclonic airflow chamber, wherein the main filter assembly includes a re-usable filter element that is easily and repeatedly cleanable by washing.

Still other benefits and advantages of the invention will become apparent to those skilled in the art upon reading and understanding the following detailed description.

Brief Description of the Drawings

The invention may take form in certain components and structures, preferred embodiments of which will be illustrated in the accompanying drawings wherein:

FIGURE 1 is a perspective view illustrating a cyclonic airflow upright vacuum cleaner in accordance with the present invention;

FIGURE 2 is a front elevational view of the vacuum cleaner illustrated in FIGURE 1;

FIGURES 3 and 4 are left and right side elevational views, respectively, of the vacuum cleaner shown in FIGURE 1;

FIGURE 5 is a rear elevational view of the vacuum cleaner of FIGURE 1;

FIGURE 6 is a bottom plan view of the vacuum cleaner of FIGURE 1;

FIGURE 7 is a front elevational view of the upright housing portion of the vacuum cleaner of FIGURE 1;

FIGURE 8 is a perspective view of the final filter assembly in accordance with the present invention;

FIGURE 9 is a side elevational view in cross-section of a vacuum cleaner with cyclonic airflow in accordance with a preferred embodiment of the present invention showing suction airflow through the cyclonic airflow dust and dirt separating chamber;

FIGURE 10 is an exploded perspective view of an upper housing member and associated depending upper conduit of the vacuum cleaner of FIGURE 9;

FIGURE 11 is a cross-sectional view of the assembled upper housing member and conduit of FIGURE 10;

FIGURE 12 is a perspective view of the upper conduit of FIGURE 10;

FIGURE 13 is an exploded perspective view of a dirt cup, main filter assembly, and filter mount means as employed in the vacuum cleaner of FIGURE 9;

FIGURE 14 is a rear elevational view of the dirt cup, main filter assembly, and filter mount means of FIGURE 13 in an assembled condition;

FIGURE 15 is a rear elevational view of a preferred main filter assembly formed in accordance with the present invention; and,

FIGURE 16 is a view taken along line A-A of FIGURE 15.

Detailed Description of the Preferred Embodiments

Referring now to the FIGURES, wherein the showings are for purposes of illustrating a preferred embodiment of the invention only and not for purposes of limiting the same, FIGURES 1-6 illustrate an upright vacuum cleaner **A** including an upright housing section **B** and a nozzle base section **C**. The sections **B**,**C** are pivotally or hingedly connected through the use of trunnions or another suitable hinge assembly **D** so that the upright housing section **B** pivots between a generally vertical storage position (as shown) and an inclined, operative position. Both the upright and nozzle sections

B,**C** are preferably made from conventional materials such as molded plastics and the like. The upright section **B** includes a handle **20** extending upward therefrom by which an operator of the vacuum **A** is able to grasp and maneuver the vacuum.

During vacuuming operations, the nozzle base **C** travels across the floor, carpet, or other subjacent surface being cleaned. The underside **24** (FIGURE 6) of the nozzle base includes a main suction opening **26** formed therein that extends substantially across the width of the nozzle base **C** at the front end thereof. The main suction opening **26** is in fluid communication with the vacuum upright body section **B** through a passage **30** and a connector hose assembly **34** (see also FIGURE 5) or a like conduit. A rotating brush assembly **36** is positioned in the region of the nozzle main suction opening **26** for contacting and scrubbing the surface being vacuumed to loosen embedded dirt and dust. A plurality of wheels **38** support the nozzle base on the surface being cleaned and facilitate its movement thereacross.

The upright vacuum cleaner **A** includes a vacuum or suction source for generating the required suction airflow for cleaning operations. With reference particularly to FIGURES 5 and 9, a suitable suction source, such as an electric motor and fan assembly **E**, generates a suction force in a suction inlet **40** and an exhaust force in an exhaust outlet **42**. The exhaust outlet **42** of the motor assembly is in fluid communication with a downstream final filter assembly **F** for filtering residual contaminants from the airstream exhausted by the

motor assembly immediately prior to discharge of the exhaust airstream into the atmosphere. The suction inlet **40** of the motor assembly **E** is in fluid communication with an upstream elongated suction conduit **46** that extends upwardly from the motor/fan assembly **E** to an upper region of the upright section **B** where it communicates with the cyclonic suction airflow dust and dirt separating region **G** of the vacuum **A** to generate a suction force therein.

With reference now particularly to FIGURES 7 and 9, the cyclonic suction airflow dust and dirt separating region **G** housed in the upright section **B** includes and is defined by an upper housing assembly **50** and a mating dust and dirt cup or container **52**. These sections **50,52** together define a generally cylindrical cyclonic airflow chamber **54**. The upper housing section **50** includes a suction airflow outlet passage **60** that communicates with the cyclonic chamber **54** through an aperture **62**. The outlet passage **60** also communicates with the motor/fan assembly **E** by way of the elongated suction conduit **46**. FIGURE 9 shows that the elongated suction conduit **46** extends from the motor/fan assembly **E** upward to communicate with the upper housing suction outlet passage **60** so that the suction inlet of the motor/fan assembly **E** is able to fluidically communicate with the cyclonic chamber **54**. It is preferred that the aperture **62** be centrally located in the cyclonic chamber **54**.

The dirt cup or container **52** defining the lower portion of the cyclonic airflow dust and dirt separating chamber **54** is constructed for large capacity and ease of

emptying the contents as necessary. The dirt container **52** defines over half the total volume of the cyclonic chamber **54**. The capacity of the container **52** is maximized to lengthen the operational time before the dirt container **52** must be emptied. Furthermore, the dirt container **52** is preferably at least partially transparent so that an operator of the vacuum is able to view the level of dirt and dust **L** accumulated therein for purposes of determining when the container should be emptied.

The dirt container **52** is connected to the vacuum upright section **B** through use of a hinge assembly **90** that allows the dirt container **52** to pivot (as indicated by the arrow **P**) between the illustrated closed, operative position and an open forwardly tilted position. Once the dirt container **52** is pivoted into its open position, it may be pulled upward and away from the section **B** and separated therefrom for ease of emptying the dirt container. A handle **96** is provided on the exterior of the container **52** to facilitate operator movement of the container between the open and closed positions, and a resiliently biased latch **98** retains the dirt container in the closed position for vacuuming operations.

The dirt container upper edge **100** defining an open upper end of the container **52** is preferably inclined downwardly in the direction away from the handle **96** or front of the container **52**. The upper housing section **50** is formed with a complimentary mating inclined lower edge **102**, and a seal such as a gasket or other structure (not shown) is preferably provided between the edges **100,102**

to prevent air leakage into the cyclonic airflow chamber **54**. The inclined upper edge **100** of the dirt container **52** also ensures that, when the container is pivoted to the open position, the upper edge **100** lies in a substantially horizontal plane. Therefore, the contents of the container are much less likely to spill when the container is opened during emptying operations. Preferably, the angle at which the upper edge **100** is inclined from horizontal is selected, in combination with the maximum distance the container is able to be pivoted on the arc **P** when opened, such that when the container is fully opened, the upper edge lies in a substantially horizontal plane.

The dirt cup **52** is shown in further detail in FIGURES 13 and 14. It includes a main filter support such as a post, stem, or like structure **150** projecting upwardly from a floor or base **152**. The floor **152** of the filter support also defines the floor of the dirt cup **52** when the main filter support is seated and suitably secured in the dirt cup. When the main filter support is operatively positioned in the dirt cup **52**, the post **150** is centrally positioned in the cyclonic airflow chamber **54** defined by the upper housing member **50** and the dirt cup **52** on a central axis **81**.

A hollow, cylindrical main filter assembly **K** is positioned over the main filter support **150**. The filter assembly **K** is engaged in an interference fit with vanes **154** and/or a disc-like plateau or boss **156** located on the floor **152** of the filter support so that the filter assembly **K** is releasably, yet securely, retained in its

operative position as shown herein, even when the dirt cup **52** is removed from the vacuum cleaner and inverted for purposes of emptying the contents thereof. An upper filter ring **158**, accommodating a gasket **159**, is provided along the uppermost edge of a main filter medium membrane **180**, and the main filter assembly **K** extends upwardly from the floor **152** to a level approximately equal to an upper edge **100** of the dirt cup **52**. Most preferably, the uppermost edge of the main filter assembly **K** as defined by the ring **158** is also sloped in the same manner as is the dirt cup upper edge **100**. Over the entire height of the dirt cup **52**, an annular cyclonic airflow passage is defined between the main filter assembly **K** and the surrounding portion of the dirt cup **52**.

A preferred embodiment of the main filter assembly **K** is illustrated in further detail in FIGURES 15 and 16. The main filter medium membrane **180** is defined in a hollow, tubular, cylindrical form from a planar, pleated filter membrane. An upper end of the pleated membrane **180** is seated in an annular groove **184** defined by the upper filter ring **158**. Likewise, a lower end of the pleated filter membrane **180** is seated in an annular groove **186** defined by a lower filter ring **157**. The rings **157,158** are preferably defined from molded plastic, and the lower ring **157** defines an aperture **188** that closely receives the boss **156** projecting from the filter support floor **152** with a tight, friction fit. The upper filter ring **158** is conformed in a manner so that, when the dirt cup **52** is in its closed position, the gasket **159** mates in a fluid-tight manner with the entire peripheral extent of

the lowermost edge **166** of an upper conduit **160** (FIGURE 9) depending into the cyclonic chamber **54** from the upper housing member **50** so as to prevent undesired airflow through an axial space between the depending conduit **160** and the filter assembly **K**. The pleated filter membrane **180** is internally supported on an open frame structure **182** that extends axially between and interconnects the lower and upper filter rings **157,158**. The open frame structure **182** does not impede airflow through the pleated filter element **180**, but ensures that the filter element will not collapse under the force of the suction airstream **J**.

A preferred medium for the filter membrane **180** comprises polytetrafluoroethylene (PTFE), a polymeric, plastic material commonly referred to by the registered trademark TEFLON®. The low coefficient of friction of a filter medium comprising PTFE facilitates cleaning of the filter element by washing. Most preferably, the pleated filter medium **180** is defined substantially or entirely from GORE-TEX®, a PTFE-based material commercially available from W.L. GORE & ASSOCIATES, Elkton, Maryland 21921. The preferred GORE-TEX® filter medium, also sold under the trademark CLEANSTREAM® by W.L. GORE & ASSOCIATES, is an expanded PTFE membrane defined from billions of continuous, tiny fibrils. The filter blocks the passage of at least 99% of particles 0.3μm in size or larger. Although not visible in the drawings, the inwardly and/or outwardly facing surface of the CLEANSTREAM® filter membrane **180** is preferably coated with a mesh backing material of plastic or the like for

durability since it enhances the abrasion-resistance characteristics of the plastic filter material. The mesh may also enhance the strength of the plastic filter material somewhat.

Referring now also to FIGURES 10-12, the relationship of the upper housing member **50** and the depending upper conduit **160** is described. The conduit **160** projects centrally downwardly into the chamber **54** from a top wall **162** of the housing member **50**. The upper conduit **160** is preferably a hollow cylindrical member with a ~~passage~~ bore **164** extending therethrough. The ~~passage~~ bore **164** is in fluid communication with the suction airstream outlet passage **60** through which the suction airflow **J** exits the cyclonic airflow chamber **54**. The conduit **160** projects downwardly from the housing top wall **162** so that the lowermost edge **166** thereof is approximately equal to the level of the lower edge **102** of the housing member **50**. Also, the lower edge **166** is sloped in a manner that corresponds to the slope of the housing member lower edge **102**. The upper conduit **160** is connected to the upper housing member **50** by any suitable means such as fasteners engaged in aligned bores **168a,168b** (FIGURE 10) respectively formed in the housing member **50** and conduit **160**. As mentioned, the gasket **159** is provided along the joint between the lowermost edge **166** of the upper conduit **160** and the upper edge of the filter assembly **K**.

With reference now specifically to FIGURE 12, an auxiliary filter support grid or framework **170** is provided and extends across the bore **164**, preferably in the region of the conduit lower edge **166**. The open

filter support **170** provides a backing member for a foam, paper, or similar conventional auxiliary filter element **174** that removes any residual dust and dirt from the suction airstream **J** prior to its exit from the cyclonic airflow chamber **54** through the bore **164** and outlet passage **60**. In case there is a break in the seal between the filter assembly **K** and the conduit **160**, the auxiliary filter **174** will prevent dirt or dust from being sucked into the motor/fan assembly **E** of the vacuum cleaner **A**. One or more tabs or teeth **176** project radially inwardly from the conduit **160** in the region of the framework **170** to engage the auxiliary filter element **174** so that the filter element is secured adjacent the framework **170** and will not be dislodged from its operative position by the force of gravity.

As is most readily apparent in FIGURE 9, the main filter assembly **K** and the upper conduit **160** together define a hollow cylindrical column extending through the center of the cyclonic airflow chamber **54** entirely between the floor **152** and top wall **162**. This preferred cylindrical columnar shape also results from the main filter assembly **K** and the upper conduit **160** having substantially the same outside diameter.

The suction airstream **J** established and maintained by the motor/fan assembly **E** enters an upper portion of the cyclonic dust and dirt separation chamber **54** through a generally tangential or offset suction airstream inlet **80** that is preferably horizontally oriented. In the preferred embodiment, as may be seen most clearly with reference to FIGURES 10 and 11, the

cyclonic chamber airstream inlet **80** is formed in the upper housing member **50**, and it is noted that the inlet **80** is disposed entirely on one side of a centerline **81** of the upper housing section so as to induce a swirling flow in the chamber **54**. As shown in FIGURE 5, the suction airstream inlet **80** is in fluid communication with a suction airstream hose **82** through a fitting **84**, and the airstream hose **82** is, itself, fluidically connected with the main suction opening **26** formed in the underside of the nozzle base **C** by way of the conduit **34** and a fitting **86**. As such, the main suction opening **26** is in fluid communication with the cyclonic chamber **54** through the passage **30**, the hoses **34,82**, and the cyclonic chamber suction inlet **80**.

The vacuum **A** also comprises a final filter assembly **F** (see e.g., FIGURES 1-3 and 5) adapted for filtering the suction airstream downstream from the motor/fan assembly and immediately prior to its exhaustion into the atmosphere. A preferred structure of the final filter assembly **F** is illustrated most clearly in FIGURE 8 and comprises a suction airstream inlet **120** which is connected downstream and in fluid communication with the exhaust outlet **42** of the motor and fan assembly **E**. The inlet **120** communicates with an elongated plenum **122** that opens to the atmosphere and houses a filter medium. A protective grid or grate structure 124 is snap-fit or otherwise effectively secured over the plenum **122** to secure the filter medium in place. The filter medium is preferably a high efficiency particulate arrest (HEPA) filter element in a sheet or block form. The filter

medium is retained in position in the plenum by the grid **124**, but is easily replaced by removing the grid. As such, those skilled in the art will recognize that even if the motor/fan assembly causes contaminants to be introduced into the suction airstream downstream from the main filter element **H**, the final filter assembly **F** will remove the same such that only contaminant-free air is discharged into the atmosphere.

Referring now primarily to FIGURES 5 and 9, the operation of the vacuum cleaning apparatus **A** is illustrated, with the flow of the suction airstream indicated by use of arrows **J**. The motor/fan assembly **E** or other suction generator establishes a suction force at its suction inlet **40**, in the elongated suction conduit **46**, and thus in the cyclonic separation chamber **54**. This suction force or negative pressure in the chamber **54** is communicated to the main suction opening **26** formed in the nozzle underside **24** through the hoses **82,34** and associated fittings. This, then, in combination with the scrubbing action of the rotating brush assembly **36** causes dust and dirt from the surface being cleaned to be entrained in the suction airflow **J** and pulled into the upper portion of the chamber **54** through the generally tangential inlet **80**.

As the suction airstream **J** enters the cyclonic chamber **54** through the inlet **80**, it travels downwardly in a cyclonic fashion so that a portion of the dust and dirt entrained in the suction airstream are separated therefrom and collected in the dirt cup **52** (as indicated at **L**). The suction airstream **J** then passes through the main filter assembly **K** to remove residual contaminants

therefrom, and moves upwardly through the main filter element **K**, through the auxiliary filter element **174**, and into the bore **164** of the depending conduit **160**. The airstream **J** is prevented from bypassing the main filter element **K** by the gasket **159** positioned axially between the filter assembly **K** and the conduit **160**. The airstream **J** then exits the cyclonic airflow chamber **54** through the outlet passage **60** and moves downwardly through the conduit **46** to the inlet **40** of the motor/fan assembly **E** and is then exhausted through the motor exhaust outlet **42** to the final filter assembly **F** where it is filtered again by the HEPA filter to remove any contaminants that passed through the chamber **54**, the main filter assembly **K**, the auxiliary filter **174**, and also any contaminants introduced into the airstream by the motor/fan assembly **E**, itself.

The position of the main filter assembly **K**, extending upwardly from the floor **152**, is highly desirable given that, as dust and dirt **L** are collected, at least a portion **M** of the suction airstream passes through the accumulated dust and dirt **L**. The accumulation of dust and dirt **L** seems to act as yet another filter element which filters more dust and dirt from the airstream **M**. Also, the flow of the suction airstream **M** downwardly through the accumulated dust and dirt **L** acts to compact the dust and dirt **L** downwardly toward the floor **152** so that the capacity of the dirt cup **52** is efficiently utilized to extend the time before the dirt cup must be emptied. As noted, a main advantage of the present invention is that the main filter assembly **K**

can be cleaned by washing it, either manually or in a dishwasher -- since it is dishwasher-safe -- to remove dust or dirt particles adhering to the filter element.

The orientation of the inlet **80** will affect the direction of cyclonic airflow, and the invention is not meant to be limited to a particular direction, i.e, clockwise or counterclockwise. Those skilled in the art will certainly recognize that the term "cyclonic" as used herein is not meant to be limited to a particular direction of airflow rotation. This cyclonic action separates a substantial portion of the entrained dust and dirt from the suction airstream and causes the dust and dirt to be deposited in the dirt cup or container.

The invention has been described with reference to the preferred embodiments. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.